3.4.2 TIA CHANNEL PLAN

The FCC Plan for the 10 Ghz band is shown in Figure 10. The TIA Plan is shown in Figure 11. The following is a comparison of the two plans:

a. The TIA Plan defines three additional 5 Mhz channels in the current point-to-point section of the band from 10550 - 10565 Mhz and 10615 - 10630 Mhz. Alcatel supports this recommendation and includes it in the Modified Plan (see Figure 12).

b. The TIA Plan replaces the Alcatel 1.6 Mhz, 800 Khz, and 400 Khz channels with 3.75 and 1.25 Mhz channels across the band. Alcatel does not support this change, and details the reasons for this conclusion in Sections 4 and 5.

c. In our original channel plan, as shown in Figure 10, Alcatel recommended that the existing 3.75, 2.5, and 1.25 Mhz channels in the 10 Ghz band should be retained. Since Alcatel does not manufacture 10 Ghz radios, we did not think it was appropriate to eliminate the existing channelizations and impact incumbent manufacturers of 10 Ghz equipment. Instead, we proposed an alternate 1.6 Mhz channel plan comparable to the plans in the 4, lower 6, and upper 6 Ghz bands. It is our belief that, as manufacturers adjust to the higher spectrum efficiency requirements in the Further Notice, the use of these older channelization plans will decline over time.

1. New York Times, December 11, 1992, p. A1

3.5 10.7 - 11.7 COMMON CARRIER BAND

3.5.1 CHANNEL BANDWIDTHS - 30 vs 40 MHZ

Another issue of some controversy among the commenters concerns the rechannelization of the 11 Ghz band from 40 to 30 Mhz channels. Alcatel made this proposal for the following reasons:

a. As shown in Figure 21, all manufacturers of 3 DS3 digital microwave radios currently are using 30 Mhz bandwidths in their 11 Ghz equipment. By rechannelizing from 40 to 30 Mhz, the number of wideband frequency pairs can be increased from 12 to 16.

b. There are currently two 40 Mhz frequency plans in widespread use in the United States: the DE plan and the PJ plan. These plans are shown in Figure 13, along with the proposed FCC Plan. Neither 40 Mhz plan is dominant: in a particular geographic area, one or the other plan will be used. Selection of the DE or PJ plan typically depends on the precedent set by previous frequency coordination activity.

   Of the 16 frequency pairs defined in the FCC plan, 4 pairs are co-channel with the existing DE frequency plan and 4 pairs are co-channel with the PJ plan. In addition, 8 pairs are offset from the DE plan by 10 Mhz and 8 pairs are offset from the PJ plan by 10 Mhz. Since these offset channels overlap the adjacent channel by only 5 Mhz, they will not interfere with an adjacent 30 Mhz radio coordinated in a 40 Mhz channel using either the DE or PJ plans. The net result is that at least 12 out of the 16 channels in the FCC channel plan can be coordinated, regardless of whether the DE or PJ plan is used in a particular area.

c. The addition of four wideband 30 Mhz channel pairs at 11 Ghz partially would offset the loss of two 30 Mhz channels pairs in the 6 Ghz common carrier band.

d. The Canadian Department of Communications recently rechannelized the upper 6 Ghz band in Canada from 40 Mhz to 30 Mhz using a plan very similar to that proposed by Alcatel in this proceeding.[2]

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2. Canadian Department of Communications, "Technical Requirements for Line-of-Sight Radio Systems Operating in the Fixed Service in the 6425-6590 and 6770-6930 Mhz Bands," SRSP-306.4, Issue 2, Effective Date: August 17, 1991.

3.5.2 TIA CHANNEL PLAN

The TIA Plan for the 11 Ghz common carrier band is shown in Figure 14, along with the existing DE and PJ plans. The TIA Plan retains the 40 Mhz DE channels, defines 30 Mhz channels using the same center frequencies as the PJ plan, adds new 20 Mhz channels, and defines 47 pairs of 10 Mhz frequencies. The advantage of this approach is that all existing DE and PJ center frequencies have been retained and no waivers would be required to overbuild existing systems.

In addition, the TIA joint commenters propose narrow band 5, 3.75, 2.5, and 1.25 Mhz channels to be overlayed onto three 30 Mhz wideband channels. These wideband channels are designated as alternate channels and are not to be used unless all other wideband channels are blocked. This narrow band proposal appears to have been made to offset the removal of narrow band channels in the 4 Ghz common carrier band.

The narrow band proposal in the TIA Plan is totally without merit. First, it would reduce the available wideband channels by 25 percent. Since 30 Mhz wideband channels already are being reduced in the 6 Ghz common carrier band, this proposal unfairly would impact LOC's, interexchange carriers, and other spectrum users with wideband channel requirements.

Second, narrow band frequencies in the 11 Ghz band are not an equivalent substitute for 4 Ghz channels since 11 Ghz is affected by rain outage. Rain outage severely restricts microwave path lengths.

Third, 100 Mhz of new spectrum is to be made available in the point-to-multipoint section of the 10.55 - 10.68 Ghz band. The 10 Ghz band has virtually identical propagation characteristics to the 10.7 - 11.7 Ghz common carrier band. Additional narrow band frequencies at 11 Ghz are not needed.

In summary, the proposal in the TIA Plan to add narrow band channels at 11 Ghz does not adequately balance the needs of different spectrum users, is not in the public interest and therefore must be rejected.

3.5.3 ALCATEL MODIFIED PLAN

Alcatel believes that our proposed 30 Mhz channel plan is the most efficient use of the spectrum. However, we recognize that there will be many requests for waivers to use the old 40 Mhz plans for overbuilding existing systems and for other special circumstances. The proposed 30 Mhz plan also would not accommodate an 11 Ghz version of the Northern Telecom 6-DS3 40-Mhz radio, although rain outage would severely limit the utility of such a radio.

If the Commission decides to retain a 40 Mhz channel plan, Alcatel recommends that the Modified Plan be used as shown in Figure 15. This plan is identical to the TIA plan for the 11 Ghz band with the following exceptions:

a. All narrow band channels are removed.

b. The TIA plan omits two of the existing 40 Mhz channels in the DE plan (designated 5E and 9D in Figure 14). These channels are restored.

c. Two additional 30 Mhz channels are added in the 60 Mhz center gap of the band. This allows the number of 30 Mhz channel pairs to be increased from 12 to 13.

d. The 20 Mhz plan is removed since it is offset 5 Mhz from the 10 Mhz plan. If a 20 Mhz channel is required, two adjacent 10 Mhz channels can be concatenated.

e. The number of 10 Mhz channel pairs is increased from 47 to 50, making more efficient use of the spectrum.

Using this plan, complete compatibility with the existing 40 Mhz DE and PJ plans is maintained. In a geographical area using the PJ plan, the 30 Mhz channel plan would be used. In an area using the DE plan, the 40 Mhz channel plan would be used. Since the 10 Mhz channels are centered on the 30 and 40 Mhz channels, a 1 DS3 system could be upgraded to a 2 or 3 DS3 system without a frequency change.

In addition, several 10 Mhz channels are included that do not overlap wideband 30 Mhz channels. These channels could be used for systems without a need for future capacity upgrades. The Modified Plan would have less 30 Mhz wideband channels than the FCC plan, but this limitation would be offset by other advantages. It would have significantly more wideband channels than the TIA plan.

4. MEDIUM CAPACITY SYSTEMS - 2.5 vs 1.6 MHZ BANDWIDTHS

4.1 COMPARISON OF THE CHANNEL PLANS

Medium capacity systems using the FCC Plan would carry 4, 8, or 12 DS1's in 1.6, 3.2, and 5 Mhz bandwidths respectively. Both Alcatel and the TIA joint commenters agree that 12 DS1 systems should use a 5 Mhz bandwidth. However, the TIA joint commenters advocate a 3.75 Mhz channel plan for 8 DS1 systems and a 2.5 Mhz plan for 4 DS1 systems. Alcatel does not support this change.

Figure 16 shows the TIA polarization plan for the 5.9 - 6.4 Ghz band. Note that there are a number of cases where a 3.75 Mhz channel overlaps two 2.5 Mhz, 5 Mhz, and 10 Mhz channels. An example is the third 3.75 Mhz channel from the left in Figure 16 (on the vertical polarization). This will cause fragmentation of the spectrum and result in blockage of various channels.

In addition, because the 5 Mhz channels are subdivided into an even number of subchannels (i.e., two 2.5 Mhz channels, four 1.25 Mhz channels), there will be polarization conficts when a mixture of different channel bandwidths are required. For example, the 5 Mhz channel at the far left of Figure 16, which is on the vertical polarization, could not be coordinated with the adjacent 2.5 Mhz channel, which also is on the vertical polarization. There are many similar cases.

To upgrade the capacity of a system from 4 DS1's to 8 or 12 DS1's, a frequency change would be required in almost every case. The TIA proposed 15 Mhz high capacity plan also would have this problem.

Figure 17 shows the TIA polarization plan for the 6.525 to 6.875 Ghz operational fixed band. Again, the 3.75 Mhz channels overlap 10, 5, and 2.5 Mhz channels. There is also a potential problem with the interstitial 5 Mhz channels. These were placed halfway between 10 Mhz channels in the existing Part 94 channelization so that narrow band analog systems could be coordinated in the gap between channels. The TIA 2.5 Mhz channels are not centered in the 5 Mhz interstitial channels, so they cannot be used if the adjacent 10 Mhz channels are used.

Figure 18 shows the polarization plan for the 5.9 - 6.4 Ghz band using the Alcatel Modified Plan. Because each 5 Mhz channel is subdivided into an odd number of 1.6 Mhz channels, polarization conflicts will not occur between 1.6 and 5 Mhz channels. The plan includes no overlapping 3.75 Mhz channels to cause spectrum fragmentation. As a result, channels can be packed closer together and the overall spectrum efficiency of the band is improved.

The FCC Plan requires a minimum of 4 DS1's in a 1.6 Mhz bandwidth. This allows a total of 72 DS1's to be coordinated in a 30 Mhz bandwidth. The TIA Plan requires 4 DS1's in a 2.5 Mhz bandwidth, resulting in a total of 48 DS1's per 30 Mhz bandwidth. Thus, the FCC Plan inherently is more spectrally efficient.

Using the FCC Plan, systems can be upgraded from a 4 DS1 system in 1.6 Mhz to an 8 or 12 DS1 system in 5 Mhz without a frequency or polarization change. It is true that an 8 DS1 system occupying a 5 Mhz channel is less spectrally efficient than an 8 DS1 system in a 3.75 Mhz channel. However, this limitation is offset by other advantages. It also is possible to use 3.2 Mhz concatenated channels for systems with no requirement for future growth.

Figure 19 shows the polarization plan for the 6.525 - 6.875 Ghz operational fixed band using the Alcatel Modified Plan. This figure demonstrates several unique characteristics of the plan. First, a system in the center 1.6 Mhz channel could be upgraded to a 5 Mhz or 10 Mhz system without a frequency or polarization change.

Second, there is a 1.6 Mhz channel centered in each 5 Mhz interstitial channel. As a result, it would be possible to coordinate narrow band 4-DS1 digital radios between two occupied 10 Mhz channels like an analog system. Note that the spectrum occupancy of a 4-DS1 radio in 1.6 Mhz is approximately the same as a 132 channel FM system.

The TIA joint commenters make a considerable issue out of the fact that a 1.6 Mhz plan has "spectrum remnants". Since the channel bandwidth was rounded off to 1.6 Mhz and 3 x 1.6 = 4.8 Mhz, there is 0.2 Mhz of "unused spectrum". Of course, this could be corrected by specifying a bandwidth of 1.6666666 Mhz. However, we believe that this "correction" is unnecessary. The FCC Plan is inherently more spectrally efficient with or without spectrum remnants.

These spectrum remnants also allow 1.6 Mhz channels to be defined without overlap in the 6 Ghz common carrier band, as proposed in the Alcatel Modified Plan. This proposal is described in Section 3.2.1.

Given the uncertainty whether adequate spectrum will be available in the bands above 3 Ghz for fixed microwave operation, it is imperative that the most spectrally efficient plan be adopted. Based on technical merits, a channelization plan based on 1.6 Mhz bandwidths is the most efficient plan.

4.2 DERIVATION OF NARROW CHANNEL BANDWIDTHS USED IN ALCATEL'S PROPOSAL

Several commenters have suggested that the Alcatel proposed narrow channel bandwidths of 1.6, 0.8, and 0.4 MHz were selected to accommodate existing Alcatel equipment and limit competition from other manufacturers. This is untrue. The selection of these narrow channel bandwidths was derived from existing FCC Part 21 rules and regulations.

Part 21.122, Microwave digital modulation, defines several requirements for transmitters employing digital modulation techniques. Part 21.122(a)(1) requires a minimum bandwidth efficiency of 1 bit/sec/Hz calculated using the emission designator of the radio. This has become a very easy specification to meet.

Part 21.122(a)(2) requires that any digital transmitter used to carry voice traffic must be capable of carrying a minimum of 1152 voice circuits in the maximum authorized bandwidth of the common carrier 4, 6, and 11 GHz bands. This requirement effectively supersedes 21.122(a)(1) and establishes the minimum bandwidth efficiency in these bands.

Part 21.122(a)(3) allows the minimum number of voice channels (1152) to be divided by a factor N, providing the maximum allowed bandwidth is also divided by N. The following chart shows the result of these calculations:

21.122(a)(3) Factor "N"	Max Authorized Bandwidth (MHz) at 4 GHz	6 GHz	11 GHz	Required Min Number of Voice Chan	Equivalent Number of DS1 Circuits
1	20	30	40	1152	48
2	10	15	20	576	24
3	6.67	10	13.33	384	16
4	5	7.5	10	288	12
6	3.33	5	6.67	192	8
12	1.67	2.5	3.33	96	4
24	0.83	1.25	1.67	48	2
48	0.42	0.63	0.83	24	1

Initial digital radio development in the early to mid 1970's concentrated in the 11 GHz band to take advantage of the wider authorized bandwidth. The most successful of these radios used 8 PSK modulation which, when filtered properly, could also be squeezed into the 30 MHz authorized bandwidth at 6 GHz. Later technology allowed the development of 16 QAM radios in the 30 MHz bands at 6 GHz. However, both 8 PSK and 16 QAM were limited and could only carry 2 DS3's (1344 voice circuits) in the authorized 30 MHz. In order to increase the bandwidth efficiency sufficient to carry an additional DS3 (3 DS3 total), radio designers were forced to use either 64 QAM or 49 QPR modulation techniques. In the early 1980's high capacity digital radio designers focused on these two modulation techniques with 64 QAM becoming most prevalent.

Once the modulation efficiency of 64 QAM became practical it was possible to design radios to meet the most stringent requirements that existed in the 4 GHz band. Due to the narrower authorized bandwidth (20 MHz), any 4 GHz digital radio has always required either 64 QAM or 49 QPR modulation techniques.

Since the OET study relied so heavily on using the 4 GHz band to accommodate current and further displaced users of the 2 GHz band and because the amount of spectrum available for point-to-point users was being dramatically reduced, Alcatel suggested that narrow band channels be established based on the bandwidth efficiency requirements that exist in the 4 GHz band today. This is how the 1.6, 0.8, and 0.4 MHz bandwidth channels and their corresponding minimum data rate requirements were established. (Please note that it was intended to allow concatenation of either two 1.6 MHz channels or four 0.8 MHz channels to accommodate 8 DS1 requirements in 3.2 MHz.)

Paragraph 21.122 was incorporated into the FCC rules 18 years ago. Digital radios employing 64 QAM or 49 QPR modulation techniques have been in production for at least 12 years. All of the major digital radio manufacturers selling to the US market (Alcatel, AT&T, Farinon, Northern Telecom, and Telesciences) have produced 64 QAM or 49 QPR radios. These facts lead Alcatel to believe that the suggested narrow channel bandwidths would not affect the industry's competitiveness and are in the best interest of the current and future users.

The "Joint Commenters" (Farinon, Telesciences, and DMC) recognize "... that the spectrum is a scarce and valuable resource that requires efficient use." (page 7) They also "... view spectrum efficiency as one of the most important factors in determining the technical rules..." (page 7) The Joint Commenters further state "... the needs of users and equipment manufacturers would be best served by a phased approach to implementing new spectral efficiency limits for digital equipment. Under this approach, existing bit efficiency would apply until the expiration of a five-year period." (page 17) To which "new spectral efficiency limits" are they referring? The existing 4 GHz, 6 GHz, or 11 GHz limits? Which "existing bit-efficiency requirements" would apply for the next five years?

Alcatel has suggested using the existing 4 GHz bandwidth efficiency requirements to accommodate the maximum number of users within the limited remaining spectrum. The Joint Commenters have suggested using the existing 4 GHz bandwidth efficiency for 5 MHz channels but then relax to the existing 6 GHz bandwidth efficiency for their proposed 2.5 and 1.25 MHz channels. Why?? Both Farinon and Telesciences have type accepted radios that carry 12 DS1's in 5 MHz or less at 6 GHz. Surely the technology required to continue this trend to 1.6 and 0.8 MHz does not elude them. Why then do they suggest 1.25 and

2.5 MHz bandwidths to handle capacities that could be accommodated in 0.8 and 1.6 MHz bandwidths, respectively?

The Joint Commenters state "... 1.25 MHz-based channels are preferable to 1.6 MHz-based channels in that they are more spectrum efficient." (page 6) The Joint Commenters support this claim by showing that 0.8 and 1.6 MHz channels do not divide evenly into 5, 10, 20 or 30 MHz thereby leaving some unused "... large spectrum remnants." They calculate this "wasted spectrum" to be 1.2 MHz per 30 MHz channel. Their argument points out that 1.25 and 2.5 MHz channels have no spectrum remnants, however, there are also 50% fewer channels available to users. This results in 10.8 MHz of "wasted spectrum" per 30 MHz channel or, stated another way, it will require 45 MHz total bandwidth to carry what could have otherwise been carried in 30 MHz. The 1.25 and 2.5 MHz channels, therefore, don't appear to be more spectrum efficient than 0.8 and 1.6 MHz channels.

To further clarify this point, Alcatel commissioned Comsearch to provide additional details of the existing users in the 2 GHz bands. There are 13,208 frequencies currently (as of late 1992) licensed in the 2130-2150, 2180-2200 MHz private/op fixed band. Of these, 6,340 occupy 1.6 MHz and 6,208 occupy 0.8 MHz. If all of these users were moved to higher frequencies using 1.25 and 2.5 MHz bandwidths rather than 0.8 and 1.6 MHz bandwidths, it would require 8.5 GHz of additional spectrum to accommodate them. This does not seem to be in the long-term best interest of microwave users or manufacturers. Furthermore, 87% of the private analog 2 GHz frequencies (approximately 21,566) and all of the common carrier digital 2 GHz frequencies can be accommodated in channel bandwidths of 5 MHz or less. This is why the maximum number of narrow band channels that can be accommmodated in the remaining spectrum is required. This is also why Alcatel suggested 1.6, 0.8 and 0.4 MHz channel bandwidths.

As a compromise to manufacturers who purport to have an equipment investment in 1.25 and 2.5 MHz bandwidth radios, Alcatel offers the following suggested amendment:

> For two years following the conclusion of these proceedings, the minimum payload capacity in 3.2 and 1.6 MHz channels is reduced by one-half to 4 DS1's and 2 DS1's, respectively.

This would allow manufacturers desiring to use 1.25 and 2.5 MHz bandwidths to use 1.6 or 3.2 MHz (or smaller using concatenation) channels and yet provide for the maximum possible number of channels for users. The two-year time frame appears appropriate since that is the approximate amount of time allowed in 1974 for a similar transition (see 21.122(d)).

4.3 USE OF THE 1.6 MHZ BANDWIDTH

The 1.6 Mhz bandwidth is not new: it is used in a number of existing microwave bands. There are 11 frequency pairs defined in Part 94 for the 2.13 - 2.2 band and 3 pairs in the 6.525 - 6.875 Ghz band. In addition, 1.6 Mhz bandwidths are used in the Part 21 section of the 2 Ghz band.

Alcatel has performed an analysis of the spectrum useage of the 2.13 - 2.2 Ghz private band using the Comsearch frequency data base. We discovered that of the 13,208 analog paths currently licensed in the band, 48% were licensed for 1.6 Mhz bandwidths and 47% were licensed for 800 Khz. The remainder used a variety of other bandwidths. This indicates that there is a huge installed base of radios using 1.6 Mhz bandwidths.

Recently, many radios in the 2 Ghz band have been coordinated for 3.5 Mhz bandwidths. The TIA joint commenters note that, in 1991, approximately 70 percent of the frequency coordinations in the 2 Ghz band used 3.5 Mhz bandwidths. Most of these coordinations were for cellular interconnects in the common carrier portion of the band. Due to the fast growing nature of these systems, cellular operators have demanded radios with the capability to upgrade quickly from 4 DS1 to 8 or 12 DS1 capacity. Since the existing 1.6 Mhz channel plan is offset from the 3.5 Mhz plan, it is necessary to change frequencies to upgrade a system if the 1.6 Mhz plan is used. As a result, most systems have tended to use the 3.5 Mhz plan for all applications.

Alcatel, Harris Farinon, and Telesciences have been the major suppliers of these 2 Ghz systems. As shown in Figure 22, both Alcatel and Harris Farinon manufacture 4-DS1 radios in the 2 Ghz band which occupy 1.6 Mhz of bandwidth. Telesciences has an 8 QAM version which occupies a full 3.5 Mhz of bandwidth and a 64 QAM version which occupies 1.6 Mhz.

The Harris Farinon/Telesciences/DMC joint commenters made the following statements:

> Since the vast majority of U.S. microwave manufacturers do not produce equipment compatible with 1.6 Mhz-based channels, the proposed channelization plans have the effect, albeit unintended, of giving a competitive advantage to one manufacturer.

This statement is not supported by the facts. As shown in Figure 22, the three largest manufacturers of medium capacity radios in the U.S. all use 1.6 Mhz bandwidths in the 2 Ghz band. Harris Farinon has a 2-DS1 radio in the 10 Ghz band which is type accepted for a 1.6 Mhz bandwidth. Western Multiplex, a manufacturer of analog radios, uses 1.6 Mhz bandwidths in its 2 Ghz and upper 6 Ghz FM radios.

The joint commenters appear to minimize the importance of capacity upgrades in their comments. This is understandable, given the clear disadvantages of their proposed plan in this regard.

Based on our past experience with the cellular industry, the emerging PCS market likely will require a large number of point-to-point microwave radios to interconnect cell sites outside of core urban areas. PCS should be very similar to the early days of the cellular industry with various system operators rushing to complete their networks and consumer demand for new services increasing at a rapid pace. In such an environment, the ability to upgrade the capacity of microwave radios will be very important.

In summary, the 1.6 Mhz bandwidth has been used in various microwave bands for many years. Several of the major radio manufacturers are currently offering equipment using 1.6 Mhz bandwidths. Manufacturers without 1.6 Mhz products should be able to adapt existing modulation processes for these bandwidths without undue hardship if a reasonable transition period is provided.

5. LOW CAPACITY SYSTEMS - 1.25 MHZ vs 800/400 KHZ BANDWIDTHS

Low capacity systems are defined as carrying 1 or 2 DS1's of digital traffic, or an equivalent 24 to 48 channels of 4 Khz analog voice traffic. The TIA joint commenters proposed that the 800 and 400 Khz channels in the FCC Plan be replaced with 1.25 Mhz channels. Alcatel opposes this change.

The FCC Plan has a fundamentally different approach to low capacity systems than the TIA Plan. Alcatel places all low capacity channels in reserved spectrum. For example, in the 6 Ghz common carrier band, low capacity channels are placed at the band edges and in the center gap so that medium and high capacity channels would not be blocked (i.e., 1.6, 5, 10, and 30 Mhz channels).

Similarly, at upper 6 Ghz, the existing band edge channels are retained for low capacity systems. At 4 Ghz and 10 Ghz, two 5 Mhz blocks of spectrum are reserved specifically for low capacity systems. No low capacity channels are provided in the 11 Ghz band, which is reserved for high capacity systems carrying 1 DS3 or more.

The TIA Plan spreads low capacity 1.25 Mhz channels across a full 80 Mhz of the 6 Ghz common carrier band. It also extends low capacity channels across the entire upper 6 Ghz private band and the 10.55 - 10.68 Ghz band.

Alcatel does not believe that the TIA plan provides a proper balance between low capacity, medium capacity, and high capacity systems. We are particularly concerned that if the WARC-92 allocations are followed and the 2.13 - 2.2 Ghz private band is reallocated for Mobile Satellite Services (MSS), a mass relocation of low capacity systems may become necessary to clear band. Current MSS systems operating in the 1530 - 1660 Mhz band do not allow sharing between MSS and fixed point-to-point services.[3]

According to an FCC Office of Engineering and Technology report,[4] there are approximately 13,000 low capacity systems in the 2.13 - 2.2 Ghz private band using bandwidths of 800 Khz and 1.6 Mhz. Under the TIA Plan, a mass relocation of these systems could cause severe spectrum fragmentation across the entire 6 Ghz common carrier and private bands, making it difficult to coordinate wider channels. The FCC Plan would direct these lower capacity systems to reserved parts of the spectrum and would preserve wider channels.

Most of the low capacity systems in the 2.13 - 2.2 Ghz private band are analog. Although Alcatel believes that many of the relocated systems will convert to digital, a significant percentage may remain analog. Analog radios for low capacity applications are low cost and spectrally efficient, can easily use 800 and 400 Khz bandwidths, and will remain a viable option for many years to come. From a spectrum management viewpoint, it is preferable to concentrate analog radios in particular sections of the spectrum to avoid carrier beat problems. The FCC Plan achieves this objective.

Comsearch frequency data indicate that, out of the 10,783 analog paths licensed in the 1.85 - 1.99 and 2.13 - 2.2 Ghz operational fixed bands, 4028 paths carry 48 voice channels or less (37% of the total) and 7031 paths carry 96 channels or less (65% of the total). In contrast to the opinion stated by the TIA joint commenters, there are a large number of low capacity systems licensed in these bands. The channelization plan adopted must accommodate these systems.

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3. John H. Lodge, "Mobile Satellite Communications Systems: Toward Global Personal Communications," IEEE Communications Magazine, November 1991, pp. 24-30.

4. Federal Communications Commission, "Creating New Technology Bands for Emerging Telecommunications Technology," OET/TS 91-1, p. 8.

Currently, no radio manufacturer offers a 1 or 2 DS1 digital radio that will occupy a 400 or 800 Khz channel. As a result, no manufacturer has an unfair advantage in the low capacity market. The spectrum efficiency requirements proposed for 1 and 2 DS1 radios are the same in bits/hertz as the requirements for 4, 8, and 12 DS1 radios. Therefore, the same modulation methods can be used.

In our research for this report, Alcatel was unable to identify any radios that have been type accepted for a 1.25 Mhz bandwidth. The only radio we could find that could actually use 1.25 Mhz is a Harris Farinon 1-DS1 radio which is actually type accepted for an 800 Khz bandwidth. We conclude that certain manufacturers have 1.25 Mhz radios in the R&D pipeline, but few currently are using these channels.

Alcatel recognizes that these manufacturers would like to leverage their investments in 10 Ghz radios and use the same 1.25 Mhz modulator designs in other frequency bands. For these manufacturers, we propose that they be permitted to use 1.25 MHz radios in 1.6 MHz channels during the two-year transition period.

The retention of 800 Khz and 400 Khz channels is supported by others in the industry. We note that Comsearch, AT&T, and MCI all advocate use of 1.6 Mhz, 800 Khz, and 400 Khz channels in their respective channelization plans.

6. CONCATENATED CHANNEL PLANS

The TIA joint commenters object to the use of concatenated frequency plans in which two or more adjacent channels are combined into a wider channel.

Alcatel proposed the concept of concatenation to allow the industry some flexibility in defining new channelization plans without requiring a lengthy petition process through the FCC. Permitting concatenated channel plans also would reduce the FCC's workload. We note that this is the second rechannelization of the 10.55 to 10.68 Ghz band in three years.

Under our concept, the 400 Khz, 1.6 Mhz, and 10 Mhz channels would become basic building blocks for low capacity, medium capacity, and high capacity systems respectively. These "building blocks" could be used to construct wider channels to solve particular spectrum management problems in the industry or to accommodate future advances in radio technology.

Figure 20 shows some concatenated frequency plans that would be acceptable to Alcatel. For high capacity systems, two 10 Mhz channels could be combined into one 20 Mhz channel. These could be used by 2-DS3 64-QAM systems with no requirement to upgrade or by 1-DS3 16-QAM radios during the transition period.

A 3.2 Mhz concatenated plan also could be defined for medium capacity systems. This plan would be used by 8-DS1 systems with no requirement to upgrade or by 4-DS1 2.5-Mhz radios during the transition period.

The third plan shows three concatenated 400 Khz channels combined into one 1.2 Mhz channel for low capacity traffic.

7. SPECTRUM EFFICIENCY REQUIREMENTS

The TIA joint commenters propose certain spectrum efficiency requirements to accommodate their 40 Mhz, 2.5 Mhz, and 1.25 Mhz channel plans. Alcatel proposes the following requirements to accommodate its Modified Plan:

Nominal Channel Bandwidth (Mhz)	Minimum Payload Capacity (Mbit/sec)	Minimum Traffic Loading Payload (as percent of payload capacity)	Typical Utilization
0.4	1.54	n/a	1 DS1
0.8	3.08	n/a	2 DS1
1.6*	6.17	n/a	4 DS1
3.2*	12.3	n/a	8 DS1
5.0	18.5	n/a	12 DS1
10.0	44.7	50	1 DS3/STS1
20.0	89.4	50	2 DS3/STS1
30.0	89.4	50	2 DS3/STS1
40.0	134.1	50	3 DS3/STS1

*The minimum payload capacity for 1.6 and 3.2 MHz channels is reduced by one-half during the two-year transition period to accommodate 1.25 and 2.5 MHz radios.

The proposed requirements are identical to those in the Further Notice, with the following exceptions:

- The minimum payload capacity for the 1.6 and 3.2 MHz channels was reduced by one-half during the two-year transition period.

- A line was added for 3-DS3 capacity in 40 Mhz to allow the DE frequency plan to be used by 3-DS3 radios in the 11 Ghz band.

Alcatel originally proposed a minimum of 2 DS3's in 30 Mhz bandwidth rather than 3 DS3's for the following reason. The 11 Ghz band is susceptible to rain outage, which restricts maximum path lengths. A 2-DS3 16-QAM radio operating in 30 Mhz has approximately 8 dB more system gain than a 3-DS3 64-QAM radio operating in the same 30 Mhz. As a result, a 2-DS3 radio is less susceptible to rain outage than a 3-DS3 radio in this band. This allows longer path lengths to be used. This is less of a concern for lower capacity radios, which generally have large system gains and can maintain higher spectral efficiency.

For channel bandwidths of 10 Mhz or greater, a minimum channel loading of 50% of the payload capacity is proposed in the Further Notice. Alcatel feels that this should refer to the loading after 5 years, as currently specified in Part 21.

Alcatel does not support the use of private auditors to enforce the channel loading requirements. Competing network operators could use this provision to harass or obtain proprietary information from competitors. The current penalties for non-compliance with FCC regulations are severe and are adequate to ensure compliance.

8. AUTOMATIC TRANSMIT POWER CONTROL (ATPC)

Most commenters favor the use of ATPC in the Part 94 operational fixed bands. However, some parties disagree whether the rule change proposed for Part 94.45(a)(10) allows APC.

Alcatel agrees that Part 94.45(a)(10) should be clarified. We propose the following alternate wording:

> Any increase in authorized effective radiated power in excess of 3 dB (a 2-to-1 ratio). For systems employing automatic transmit power control, this applies to the maximum transmit power when the ATPC function is disabled.

In Part 21 bands, radios always are licensed for the maximum transmit power (i.e., with ATPC disabled). Radios are permitted to operate at lower power as long as the licensed power is not exceeded. Therefore, there is no need to revise Part 21 in this regard.

Some commenters suggest that additional detail should be added to the FCC regulations describing the specific operational characteristics of ATPC systems. Alcatel disagrees. ATPC has been used successfully in Part 21 bands for many years without detailed specifics in the regulations. Industry groups, such as the NSMA, have cooperated with manufacturers to outline operational and frequency planning guidelines for ATPC systems. These could be published in a TIA standard.

9. VIDEO TRANSMISSION SYSTEMS

In its comments, the Public Broadcasting Service ("PBS") expresses reservations to the proposed spectrum efficiency requirements in the Further Notice. PBS would like to generate a QPSK modulated video signal in the studio, send this signal over microwave entrance links to a satellite uplink, and reverse the process on the downlink side. This system would effectively bypass the encoding of the signal into North American digital transmission rates (DS1, DS3, STS-N). PBS proposes an exception to the spectrum efficiency rules to allow this specific implementation.

Alcatel believes that the spectrum efficiency requirements in the Further Notice would not apply to the PBS system as proposed. Since no digital encoding is performed to North American transmission rates, PBS effectively would be using an analog radio in the entrance links. The signal would not be regenerated at repeaters and would suffer the same build-up of noise as in other analog systems. This would be equivalent to connecting a 1200 baud modem to an analog radio. Since the spectrum efficiency rules would not apply to analog radios, an exception to the rules would not be necessary.

PBS states that common carriers will not be able to transmit HDTV video signals on digital microwave networks. Alcatel disagrees. Studio quality NTSC video is transported today using video codecs at equivalent or better quality than old analog systems. Alcatel supplied such codecs to the 1988 Summer Olympic Games in Seoul, South Korea to transport television pictures from local events to the satellite uplinks. Typical data rates for studio quality video are 1 or 2 DS3's. Higher bandwidth HDTV video signals can be transmitted in a similar manner using higher capacity codecs.

10. AT&T CHANNEL PLAN

Alcatel has studied AT&T's comments in some detail. Many of AT&T's observations regarding existing frequency plans are useful and Alcatel incorporates these suggestions into the Modifed Plan. For example, we have recommended the continued use of the AT&T 29.65 Mhz frequency plan in the 6 Ghz common carrier band. We note that AT&T advocates the use of 1.6 Mhz, 800 Khz, and 400 Khz channels for medium and low capacity traffic.

Nevertheless, Alcatel has serious reservations about AT&T's overall channelization plan. It appears that AT&T's primary intent is to reserve as much spectrum as possible from the band edges and guard bands of the common carrier bands for future PCS projects. AT&T proposes to reserve 20 Mhz at 4 Ghz, 25 Mhz at 6 Ghz, and 30 Mhz at 11 Ghz for unspecified future purposes. These are the segments of spectrum that the FCC Plan has designated for low capacity relocations from the 2 Ghz band.

10.1 WIDEBAND CHANNELS

AT&T makes no attempt to segregate wideband 10, 20, 30, and 40 Mhz channels from narrow band channels, thereby decreasing the spectral efficiency of its plan. For example, a 1-DS1 radio occupying 400 Khz of bandwidth could block a wideband 30 Mhz channel in the 6 Ghz common carrier plan.

10.2 UPPER 6 GHZ OPERATIONAL FIXED BAND

In the 6.525 - 6.875 Ghz operational fixed band, AT&T proposes a new 5 Mhz channelization that is offset by 2.5 Mhz from the existing plan. Although the AT&T plan likely would prove adequate if the band were free of incumbent users, it is seriously flawed in the current environment. Large numbers of analog <u>and</u> digital systems have been installed using the existing 5 Mhz channels. Changing the channelization at this point would severely disrupt the orderly management of the band.

AT&T has strongly urged the Commission to retain the existing center frequencies in the 6 Ghz and 11 Ghz common carrier bands. The same reasoning applies to the 6 Ghz private band. Alcatel is opposed to this change in the 5 Mhz channel plan.

10.3 11 GHZ COMMON CARRIER BAND

AT&T proposes to overlay medium and low capacity channels in the 11 Ghz band using an approach similar to the TIA Plan. It totally disregards the 100 Mhz of additional spectrum to be made available in the 10.55 - 10.68 Ghz band. This does not provide a proper balance between low capacity, medium capacity, and high capacity spectrum use.

10.4 CHANNEL PAIRINGS

AT&T recommends that the old channel pairings in the 4 Ghz and 11 Ghz common carrier bands be maintained. This could be justified if microwave users were still installing long haul systems using full blocks of frequencies as they were 20 or 30 years ago. However, most new microwave paths are for cellular and private networks. The overwhelming majority of these paths use a single transmit/receive frequency pair. The frequency pairings listed in the FCC regulations should accommodate these new patterns of spectrum use.

The AT&T pairing plan for the 4 Ghz band is not cost effective for systems using a single transmit/receive frequency pair because separate transmit and receive antennas would be required on every path. This was discussed in Section 3.1.2 above.

The AT&T pairing plan for the 11 Ghz band would not accommodate the addition of the 13th 30-Mhz frequency pair proposed in the Alcatel Modified Plan. Under the AT&T plan, only 12 frequency pairs could be defined.

Alcatel is a major supplier of 1, 2, and 3 DS3 radios in the 11 Ghz band. We have observed that few network operators outside of AT&T actually use the rigorous frequency growth plan described in the AT&T comments. Many operators, particularly in the developing cellular industry, are not even aware that this plan exists. Mandating the use of the AT&T plan at this point would make it difficult to coordinate 11 Ghz frequencies in congested urban areas.

The AT&T channel pairings for these bands are essentially obsolete. Consequently, Alcatel recommends the pairings in its Modified Plan to better accommodate current spectrum use.

10.5 USE OF THE 6 GHZ BAND FOR PCS

As noted above, the AT&T channel plan would leave the band edges and center gap of the 5.9 - 6.4 Ghz band vacant for future PCS applications. Certain points should be made about this aspect of the plan.

The 6 Ghz common carrier band is ill-suited for PCS applications because it is shared with satellite uplinks. It would be virtually impossible to calculate the aggregate interference level of thousands of omnidirectional PCS transmitters across the continental U.S. interfering with a satellite in the geosynchronous orbit. Satellite transponder frequencies completely overlay the 6 Ghz band. Therefore, all frequencies, including the band edges and center gap sections, would be equally susceptible to PCS interference.

For 40 years, 6 Ghz has been the preferred band for high capacity common carrier applications. It is heavily congested in urban and rural areas across the country. Placing PCS in the center gap of the 6 Ghz band would subject the huge installed base of 6 Ghz radios to potential adjacent channel interference. Alcatel has shown[5] that a single unlicensed PCS transmitter in the 1910-1930 Mhz band can cause significant threshold degradation to a point-to-point digital receiver in the adjacent 10 Mhz channel. This is less of a concern in the 1.85 - 1.99 Ghz band, which is relatively uncongested. However, it should be a major consideration in the heavily congested 6 Ghz band.

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5. Comments of Alcatel Network Systems, Inc., Federal Communications Commission, ET Docket 92-100, November 6, 1992.

AT&T has major corporate interests in the manufacture of PCS products and has redirected much of their interexchange traffic to fiber systems. It may be less concerned about the long term viability of point-to-point microwave in the 6 Ghz band than other users of the band. Alcatel supports efforts to find additional spectrum for PCS applications. However, we do not believe that 6 Ghz is the appropriate band for these applications.

11. OTHER CHANNELIZATION PLANS

11.1 BELL ATLANTIC PLAN

Bell Atlantic recommends that the existing T-plan be retained in the 6 Ghz common carrier band, which uses 29.65 Mhz frequency spacings. Alcatel agrees with Bell Atlantic and has incorporated the T-plan into its Modified Plan.

11.2 COMSEARCH PLAN

Comsearch proposes a 4 Ghz plan which corrects certain frequency pairing problems in the FCC plan. Alcatel agrees with the intent of the Comsearch plan and has revised the frequency pairings in its Modified Plan. The frequency pairings in the Modified Plan were designed to be compatible with the existing AT&T pairings.

11.3 NORTHERN TELECOM PLAN

Northern Telecom recommends new 40 Mhz bandwidths for the 4, 6, and 11 Ghz common carrier bands.

Alcatel opposes 40 Mhz bandwidths in the 4 Ghz band due to interference into satellite earth stations. This was discussed in Section 3.1.3.

Northern Telecom is the only commenter to propose a 40 Mhz channelization for the 6 Ghz band. Alcatel questions whether this plan will be of any practical benefit since each 40 Mhz channel overlaps two existing 30 Mhz wideband channels. Due to the congested nature of the 6 Ghz band, it then would be extremely difficult to coordinate two pairs of adjacent 30 Mhz channels. A single 40 Mhz channel also could block the majority of narrow band 5 and 1.6 Mhz channels. Alcatel is opposed to the 40 Mhz plan.

In the 11 Ghz band, Northern Telecom recommends that the existing 40 Mhz DE and PJ plans be retained. Alcatel supports this recommendation and incorporates these channelizations into its Modified Plan (see Section 3.5.3).

Northern Telecom reduced the number of 10 Mhz channels in all its frequency plans. Alcatel can see no justification for this change.

12. FREQUENCY COORDINATION

Alcatel strongly agrees with the TIA that prior coordination should be required in all operational fixed bands above 1 Ghz. Prior coordination is defined in Part 21.100(d)(1).

Prior coordination will improve the accuracy of frequency coordinations because it will ensure that all frequency data bases are up-to-date. Currently, data bases for operational fixed bands may be months out of date due to the time lag between system installations and license notifications.

Prior coordination should be required in the 1.85 - 1.99 Ghz and 2.1 - 2.2 Ghz bands to inform operational fixed users of proposed PCS installations in their area. This will provide the fixed users with an opportunity to perform a technical analysis of the PCS interference before the system is installed.

Regarding the technical requirements for frequency coordination, Alcatel supports the method proposed in the Further Notice. Any user coordinating a path in a Part 94 band should use Part 94 technical requirements, including accepted interference standards such as EIA/TIA Bulletin 10. Users in a Part 21 band should use Part 21 interference standards.

As a practical matter, frequency planners tend to use the same methods for both Part 94 and Part 21 bands. Manufacturers' published threshold-to-interference curves are normally used to determine allowable interference levels for digital radios. Published receiver susceptibility curves are used for analog radios. These curves generally limit interference levels to less than 1 dB of receiver threshold degradation.

When this information is not available, the carrier-to-interference (C/I) objectives published in Bulletin 10 are used in Part 94 bands and the C/I objectives from the NSMA are used in Part 21 bands. Although these C/I objectives are not exactly the same for the common carrier and private bands, they are extremely stringent in both cases. For example, the NSMA tables for the common carrier bands were originally developed by AT&T for long haul microwave systems. These systems were designed for path outage of only a few seconds per year. Private users should have no undue concern using the Part 21 standards.

The TIA, in association with the NSMA, should work toward common frequency coordination procedures in Part 94 and Part 21 bands. These could be published as technical standards. In the interim period, current technical standards for each service should be maintained.

13. EQUIPMENT AVAILABILITY

Some commenters question how soon microwave radios will become available if Alcatel's spectrum efficiency requirements were adopted. Alcatel notes that many currently available radios already meet these requirements.

Figure 21 shows existing high capacity radios from various manufacturers. The radios that currently meet the proposed spectrum efficiency requirements are marked with an askerisk. Out of the 26 high capacity radios in the table, 24 meet the proposed spectrum efficiency requirements. Radios with 1, 2, and 3 DS3 capacity are currently available in all affected bands.

Figure 22 shows typical medium and low capacity radios. Alcatel, Harris Farinon, and Telesciences all have 12-DS1 radios in the 6 Ghz common carrier and operational fixed bands which will meet the proposed spectrum efficiency requirements. In the 10 Ghz band, Telesciences has a 12-DS1 radio that meets the requirements.

Telesciences currently has a 4-DS1 radio in the 2 Ghz band which occupies a 1.6-Mhz bandwidth. It could use the modulator from the 2 Ghz radio to develop 4-DS1 versions in the other frequency bands (4, 6, and 10 Ghz). To reduce development costs, the RF portion could be reused from existing radios in each band. Telesciences also could adapt the 128 QAM modulator used in its 2-Ghz 12-DS1 radio to fit 8-DS1's into 3.2 Mhz.

The most difficult and expensive part of a radio development is the modulators and demodulators. Adapting existing modulators for lower bit rates or moving them to other frequency bands is much less costly and time consuming than developing an entirely new modulation method.

Similarly, Harris Farinon is using 49 QPRS modulation in its new medium capacity 6 Ghz radio, providing 12-DS1's in 5 Mhz. This modulation has the spectral efficiency to fit 8 DS1's in 3.2 Mhz and 4 DS1's in 1.6 Mhz. Harris is using this same 49 QPRS modulation in its 8-DS1 radio in the 10 Ghz band and 4-DS1 radio in the 2 Ghz band. The R&D development involved in these modifications should be relatively straightforward.

Digital Microwave Corporation uses 64 QAM modulation in its high capacity 1-DS3 radio in the 6 Ghz operational fixed band. This modulation method could be adapted for medium and low capacity radios.

All manufacturers, including Alcatel, have radios that will not meet the new spectrum efficiency requirements. However, these older radios still would be available during the proposed transition period. Continuity in the industry would be maintained.

14. TRANSITION PERIOD

Alcatel agrees with the TIA joint commenters that there should be a reasonable transition period before the new spectrum efficiency requirements become effective. This will allow point-to-point microwave users to purchase older, less spectrally efficient radios while newer products are under development.

The TIA joint commenters recommend a 5 year transition period. Alcatel disagrees with this recommendation and proposes a 2 year transition.

Under a 5 year transition plan, manufacturers would have little incentive to develop more spectrally efficient radios. The great bulk of relocated 2 Ghz systems would be forced to use the older, less efficient requirements currently in the FCC regulations.

The FCC order providing for secondary status in the 1.85 - 1.99 and 2.1 - 2.2 Ghz bands was issued approximately one year ago. As a result, radio manufacturers already have had one year to develop alternate products. In that time, both Harris and Alcatel have developed new medium capacity 6 Ghz radios that meet the proposed spectrum efficiency requirements. If a 2 year transition period started tomorrow, the effective transition period actually would be 3 years.

Alcatel proposes the following procedure for implementing this transition period. The channelization plans and other rule changes would become effective immediately for the spectrum efficiency requirements of Part 21.122.

The Part 21 regulations would be modified to exempt radios using bandwidths of 15 Mhz or less from the minimum voice channel and data loading requirements of Part 21.710. This would allow 1-DS3, medium capacity, and low capacity radios into applicable Part 21 bands. During the transition, spectrum efficiency requirements would be defined by the current requirements of Part 21.122 using the 1/N rule.

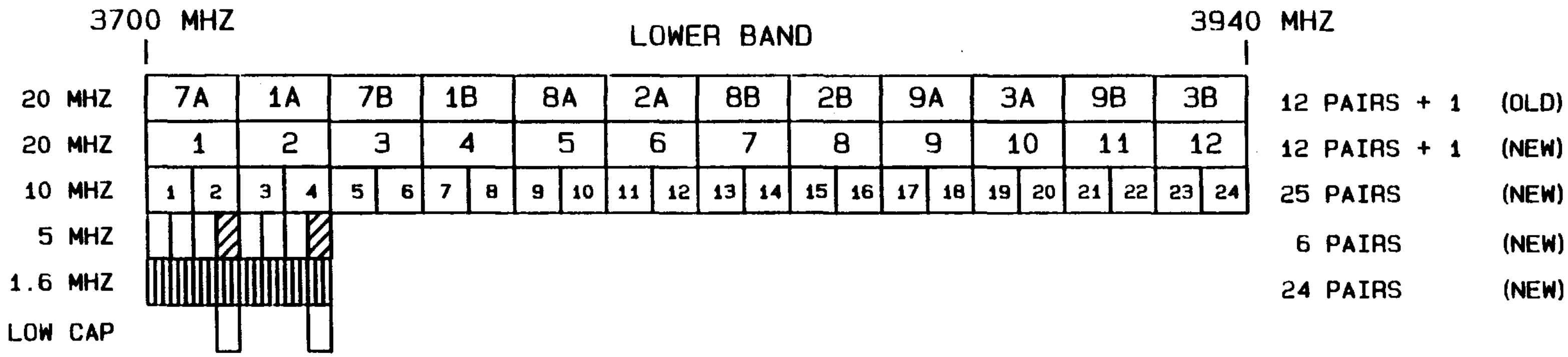
At the end of the transition period, the new Part 21.122 spectrum efficiency requirements would become effective. This procedure will allow for an orderly transition.

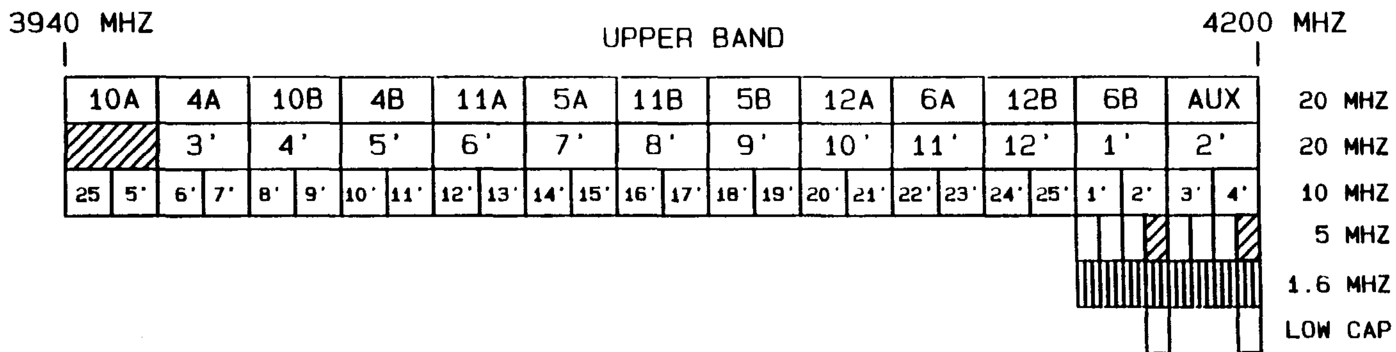
15. MODIFIED CHANNEL PLAN

Appendix A lists center frequencies for the Alcatel Modified Plan described in this report. Some frequencies in the FCC Plan were changed to correct errors and reduce the number of decimal places.

An electronic copy of the modified frequency plan on a DOS compatible floppy disk is available upon request.

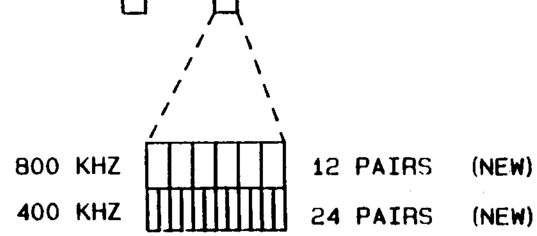
FCC CHANNEL PLAN – 4 GHZ BAND





NOTE: 1. 20 MHZ CHANNELS 1 AND 1', 2 AND 2' ARE ALTERNATE CHANNELS

2. 10 MHZ CHANNELS 1 TO 4, 1' TO 4' ARE ALTERNATE CHANNELS



3.7 – 4.2 GHZ
COMMON CARRIER BAND
FREQUENCY CHANNELIZATION

Figure 1

TIA CHANNEL PLAN – 4 GHZ BAND

LOWER BAND

3700 MHZ — 3940 MHZ

40 MHZ	1		1'		2		2'		3		3'		6 PAIRS (NEW)
20 MHZ	7A	1A	7B	1B	8A	2A	8B	2B	9A	3A	9B	3B	12 PAIRS + 1 (OLD)

UPPER BAND

3940 MHZ — 4200 MHZ

4		4'		5		5'		6		6'			40 MHZ
10A	4A	10B	4B	11A	5A	11B	5B	12A	6A	12B	6B	13A	20 MHZ

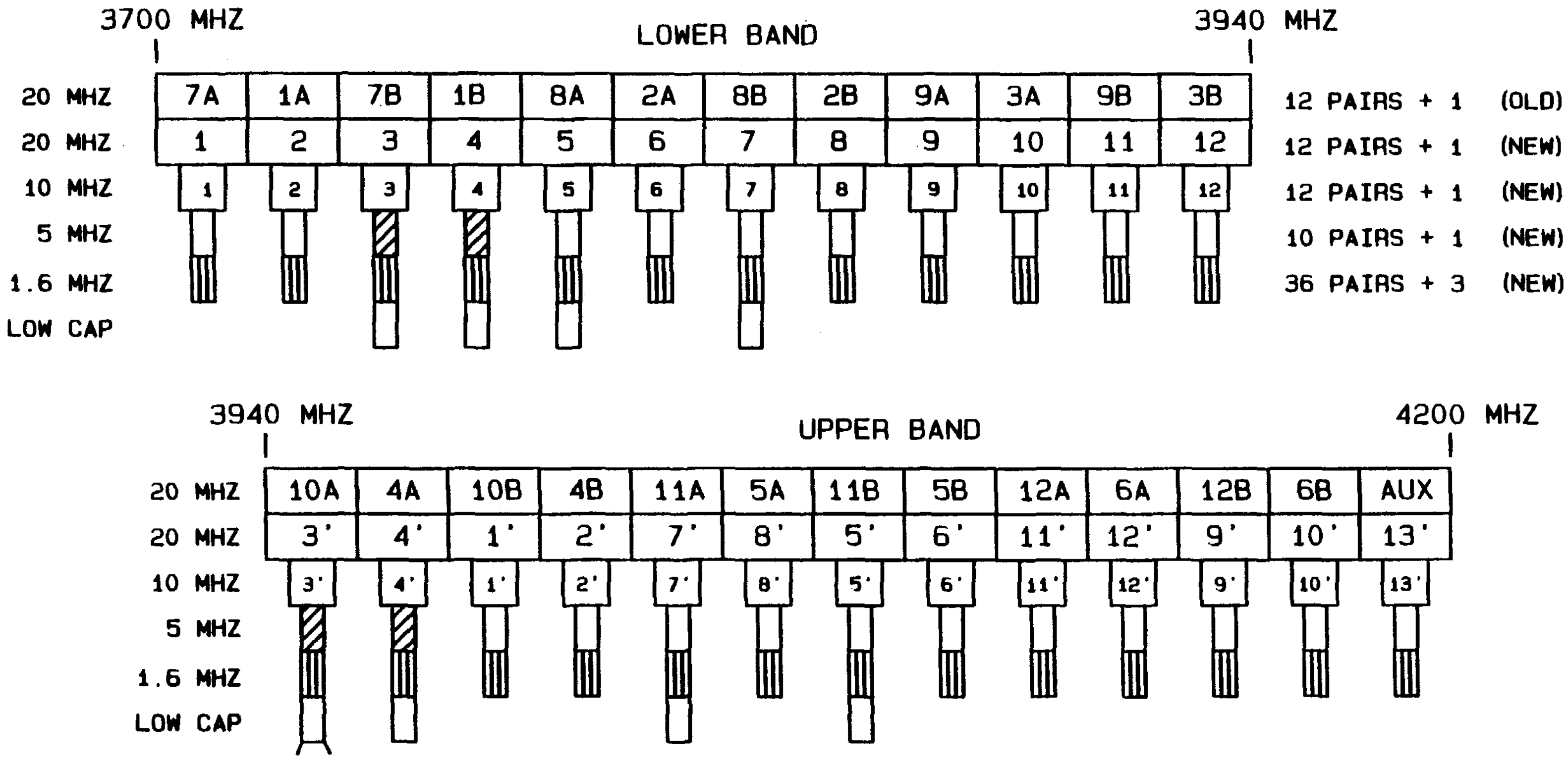
NOTE:

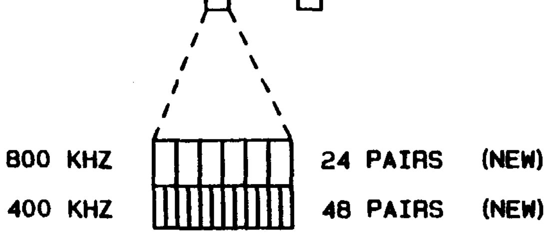
1. EXISTING 20 MHZ PLAN RETAINED
2. NEW 40 MHZ CHANNELS ADDED
3. ALL NARROW BAND CHANNELS REMOVED

3.7 - 4.2 GHZ
COMMON CARRIER BAND
FREQUENCY CHANNELIZATION

Figure 2

ALCATEL MODIFIED CHANNEL PLAN – 4 GHZ BAND





NOTE:

1. 20 AND 10 MHZ CHANNELS 3 AND 3', 4 AND 4' ARE ALTERNATE
2. 5 AND 1.6 MHZ CHANNELS 6 AND 6', 8 - 12, AND 8' - 12' ARE ALTERNATE
3. 800/400 KHZ CHANNELS WITHIN 20 MHZ CHANNELS 5 AND 5', 7 AND 7' ARE ALTERNATE
4. ALTERNATE CHANNELS SHOULD ONLY BE USED IF ALL OTHER CHANNELS ARE BLOCKED
5. AUXILIARY CHANNEL 13' IS AVAILABLE FOR UNPAIRED USE

3.7 - 4.2 GHZ
COMMON CARRIER BAND
FREQUENCY CHANNELIZATION

Figure 3